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The production of seed of the scallop "hotategai".*

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Toshisuke TANAKA, Atsushi SATO, Kaname KAWAMURA

Introduction

Studies made during the past year in relation to the development of techniques for the production of scallop seed have included the following:

- (1) The ripening of the gonads of scallops in Mutsu Bay
- (2) The spawning that results from the induction of spawning
- (3) The rearing and transfer to the sea of free-swimming scallop larvae
- (4) The early settling of cultivated spat and the growth of natural spat.

1. The changes of scallop gonads

1.1. Changes of scallop gonads (November 1974 to May 1975)

Materials and methods

The scallops studied were two and three years old in suspended cultivation from Okunai (Aomori city), Moura (Hiranaicho), Yokohamacho,

* The species name is not given, but "hotategai" is normally Pecten (Patinopecten) yessoensis JAY. Translator

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and Funaoka (Tairadate village). The gonads of 20 to 30 individuals were measured on each of 27 occasions between 26 November 1974 and 14 March 1975.

Results and discussion

The variations in gonad weight are shown in Figure 1, and the variations in the gonad index are shown in Figure 2.

$$\text{Gonad index} = \frac{\text{Weight of gonads}}{\text{Weight of soft parts}} \times 100$$

As shown in Figure 2, the maximum occurred at Okunai (Aomori city) on 10 February. At Moura (Hiranaicho) some ripeness of the gonads was observed on 6 February, but it was then already close to the maximum which it reached on 20 February. At Yokohamacho it was 27.6 ± 3.2 (23.0 to 34.1)% on 3 February, and about a month later on 7 March it was still the same, 27.6 ± 4.8 (14.3 to 36.5)%. Figure 3 shows the seasonal frequency distribution of the gonad index at the three locations in Mutsu Bay, Okunai (Aomori city), Moura (Hiranaicho) and Yokohamacho.

Ripeness occurs earliest in Okunai (Aomori city) and somewhat later than this at Moura (Hiranaicho) and at Yokohamacho.

1.2 Changes of scallop gonads (November 1975 to March 1976)

Materials and methods

The scallops studied were two and three years old in suspended cultivation from Funaoka (Tairadate village), Ushirogata (Aomori city), Okunai (Aomori city), Yokohamacho and Ominato (Mutsu city). The gonads of 20 to 30 individuals were measured on each of 54 occasions between 30 November 1975 and 31 March 1976.

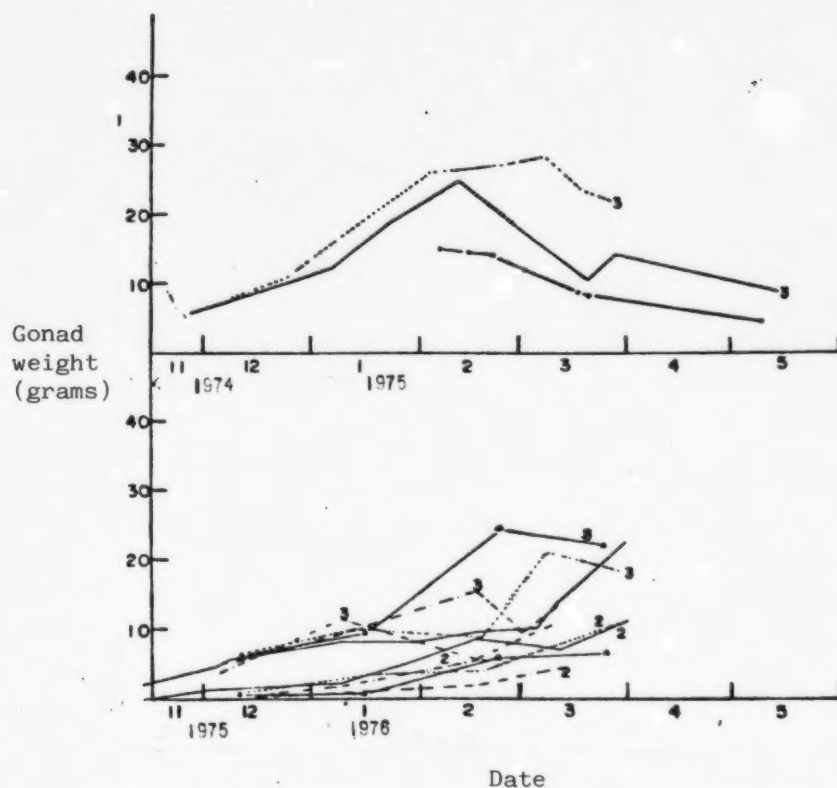


Figure 1. Annual variations in gonad weight

-- Tairadate	--- Ushirogata
— Okunai (Aomori)	-o- Moura (Hiranaicho)
--- Yokohamacho	-△- Ominato (Mutsu)

The numbers in the Figure show the ages of the scallops

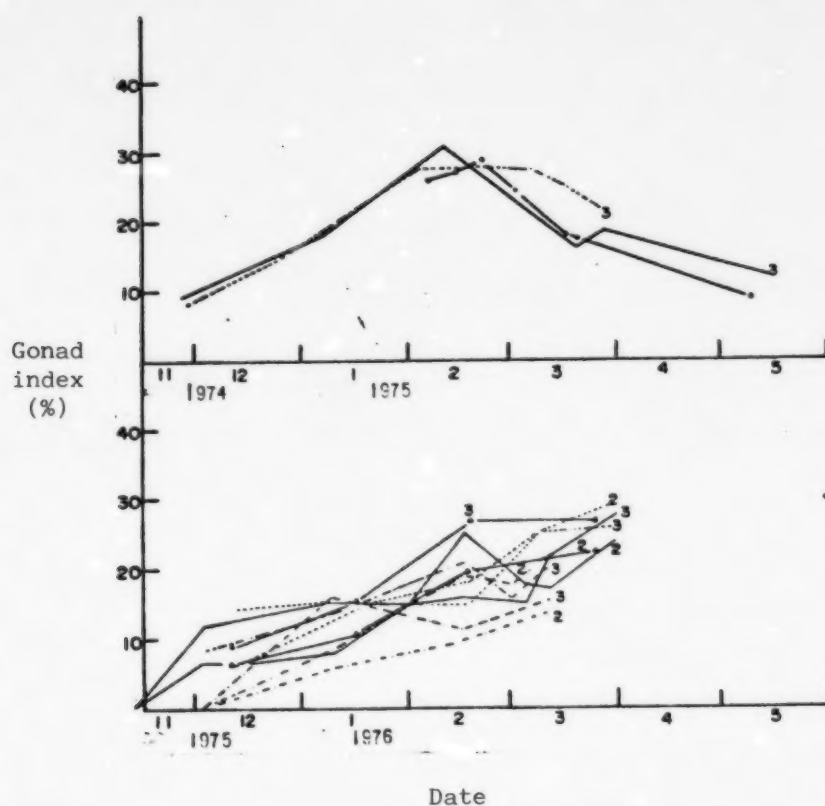


Figure 2. Annual variations of the gonad index

-.- Tairadate	--- Ushirogata
— Okunai (Aomori)	-o- Moura (Hiranaicho)
---- Yokohamacho	-▲- Ominato (Mutsu)

The numbers in the Figure show the ages of the scallops.

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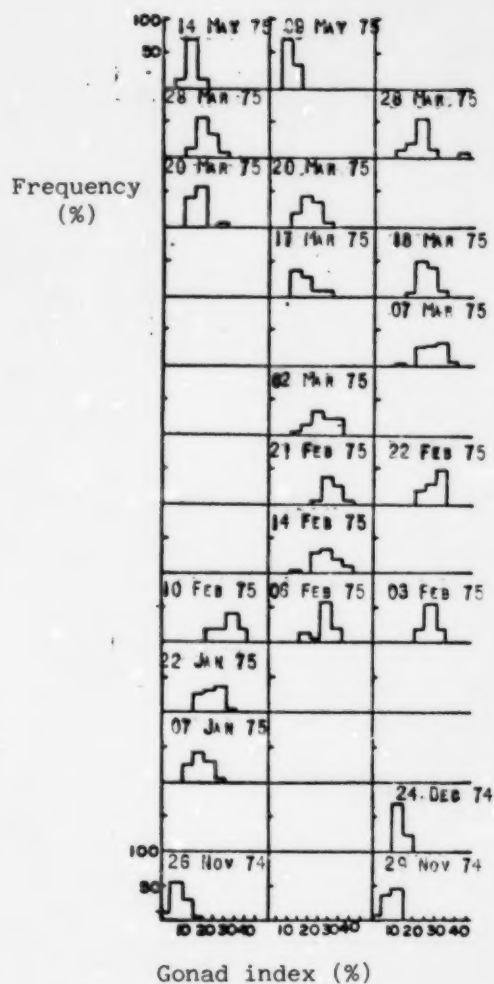


Figure 3. Variations of the scallop gonad index

From left to right, three year-old scallops from
suspended cultivation in Okunai (Aomori city),
Moura (Hiranaicho) and Yokohamacho.

The dates of measurement are shown in the Figure.

Results and discussion

The variations in gonad weight are shown in Figure 1, and the variations in the gonad index are shown in Figure 2.

As shown in Figure 2, the increase of gonad index after November 1975 occurred rather later than in the same season of the previous year. For example, in 1975 the gonad indexes of the three-year old scallops at Okunai (Aomori city) and at Yokohamacho were already greater than 20% by the middle of January and although they were not measured, this was also true of the three-year old scallops at Moura (Hiranaicho). However in 1976 the gonad indexes of the scallops measured in all areas in the last part of January were all less than 20% and the three-year old scallops at Ominato (Mutsu city) only slightly exceeded 20% in early February.

Taking each location separately from November 1975 to March 1976 shows that even by the middle of March the gonad index at Funaoka (Tairadate village) of both two-year old and three-year old scallops was 15% and this value was not exceeded. At Ushirogata (Aomori city), the three-year old scallops reached their maximum, 20.9 ± 6.1 (8.9 to 32.4)% in the middle of February, and the two-year old scallops reached their maximum, 19.0 ± 4.5 (12.5 to 29.0)% at the same time, and then the gonad indexes of both declined. In the middle of March the three-year old scallops had returned to a value near that of mid-February, and the two-year old scallops had slightly exceeded the three-year old value. At Okunai (Aomori city) the gonad index of three-year old scallops in suspended culture scarcely increased from 3 December to 4 March of the next year, and remained effectively constant from 15.3 ± 1.7 (12.5 to 19.2)% on 9 January to 15.1 ± 3.1 (10.0 to 21.0)% on 5 March. It then increased and was 27.9 ± 3.9 (21.7 to 35.7)% on 31 March.

The maximum values of the gonad index in 1975 were 30.9% on 22 January and 31.0 ± 4.1 (23.8 to 38.5)% on 10 February, so that ripeness was about two months earlier than in 1976 when it was in late March. At Yokohamacho both two-year old and three-year old scallops had gonad indexes about 25% on 8 March, but in 1975 25% was exceeded in late January and by early March the gonad index had started to decline, so that ripeness was about one month later. However even in late March neither the two nor the three year scallops had a mean value of more than 30%.

This shows that the ripeness of the gonads in 1975 and 1976 does not depend solely on the locality but that it was from one to two months later in 1974 than in 1975.

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2. Scallop spawning

2.1 The induction of scallop spawning

Materials and methods

The scallops used in the study were three-year old scallops taken from suspended culture on 22 January and 5 March at Okunai (Aomori city) and three-year old scallops taken from suspended culture on 25 March at Yokohamacho.

The method used in the previous year for inducing spawning employed sea water which had been irradiated with ultraviolet radiation and warmed¹. Because it had been found to be highly effective, the ultraviolet irradiation vessel used in the previous year in this method of inducing spawning was continued in use.

In this method of inducing spawning, heat controlled filtered seawater was stored in a holding tank and passed at a determined flow rate

through the ultraviolet irradiation vessel. Through regulation of the flow rate the warm seawater could receive 0, 3, 4, 5 or 6 units of radiation in the irradiation vessel and it then flowed through 13-litre tanks each housing one individual scallop. The flow in each irradiation vessel was controlled at 700 to 1000 millilitres per minute.

Five male and five female scallops were placed in 13-litre tanks at one scallop per tank. Spawning induction was discontinued five hours after the start¹ and the quantity of spawn and the "much or little" discharge of sperm were observed, the release of sperm producing a white turbidity in the water in the 13 litre tank. If the scallop could not be seen the release was classified as "much", if it could be seen as "little".

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Results and discussion

The effectiveness of the warmed ultraviolet irradiated water in inducing spawning during the induction period is shown in Figure 4.

The first trial of inducing spawning was made on 28 January. The seawater used was not warmed but the original temperature of the seawater was slightly increased from 5.7°C to between 6.7°C and 7.5°C by the ultraviolet irradiation. The gonad index of the scallops used in the first trial of inducing spawning was 23.7 ± 3.8 (17.7 to 30.9)%, but in no case was there spawning or sperm discharge.

The second trial of inducing spawning was made on 5 to 7 March. On 5 March spawning was induced with ultraviolet irradiated seawater warmed to 8.1°C to 10.5°C. With 3 units of radiation there was 10% (male) and with 5 units 20% (male).

The spawning induction was discontinued after five hours and the scallops were then set aside in a current of filtered water. On 6 March the

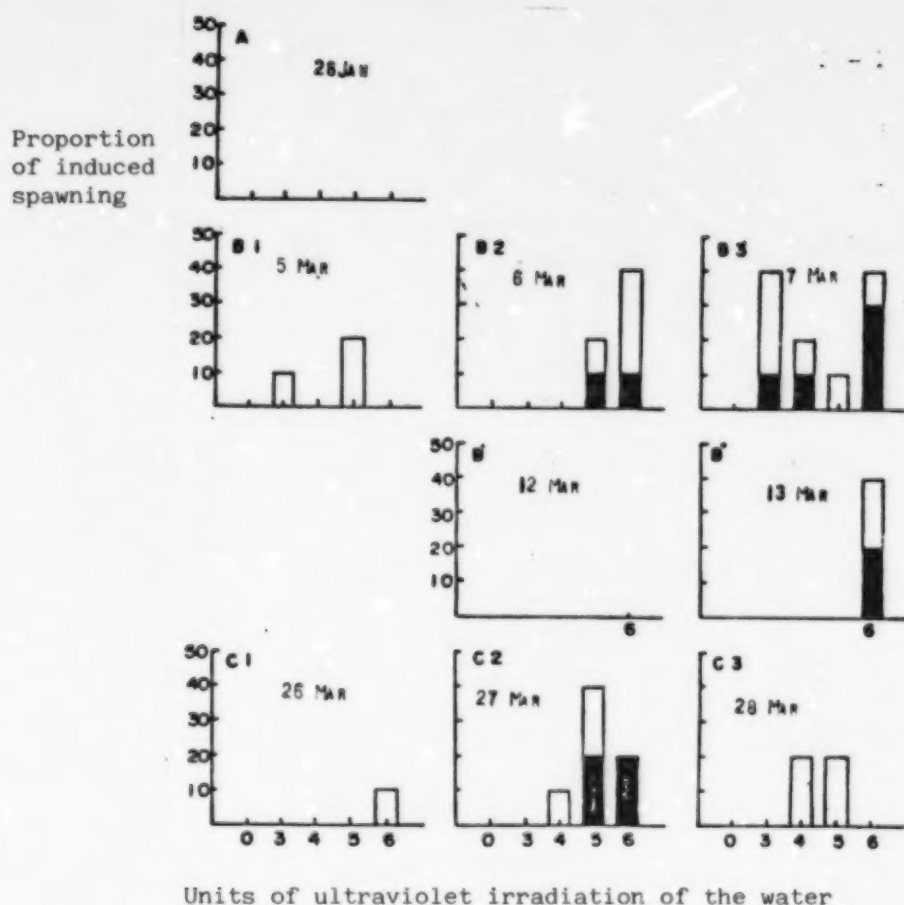


Figure 4. The proportion of spawning induced by season, water temperature and ultraviolet irradiation.

Table 1. Water temperatures during spawning induction.

Units	A	B - 1	B - 2	B - 3	B'
0	6.7	8.1 - 10.1	10.1 - 12.3	14.1 - 14.8	
3	6.9	8.9 - 10.4	10.3 - 12.3	14.1 - 14.9	
4	7.2	9.3 - 10.6	10.4 - 12.5	14.5 - 15.3	
5	7.4	9.4 - 10.5	10.6 - 12.7	14.5 - 15.4	
6	7.5	9.4 - 10.5	10.6 - 12.7	14.6 - 15.5	12.3 - 12.7
Original water temperature	5.7	5.0	5.3	5.4	6.0

Units	B''	C - 1	C - 2	C - 3
0		9.9 - 10.6	11.0 - 11.7	14.1 - 14.4
3		10.3 - 10.7	11.2 - 11.9	14.1 - 14.5
4		10.6 - 11.4	11.4 - 12.1	14.1 - 14.6
5		11.4 - 11.8	11.5 - 12.4	14.5 - 15.0
6	14.4 - 16.2	11.4 - 12.5	11.5 - 12.8	14.5 - 15.0
Original water temperature	6.6	5.9	6.6	6.1

same scallops were used (though fresh scallops were used to replace those which had spawned or discharged sperm) and spawning was induced in water warmed to 10.1°C to 12.7°C . This time the induction rate with 5 units was 20% and with 6 units 40%. Similarly some individuals responded on 7 March to induction with water warmed to 14.1°C to 15.5°C flowing through the irradiation vessel and irradiated with 3, 4, 5 and 6 units. However when induction was tried from 5 March to 7 March using as the stimulus water which had only been warmed without ultraviolet irradiation no spawning or sperm discharge was found. When this second trial had been terminated, 5 males and 5 females from the group which had been stimulated from 5 March to 7 March by warmth alone without the use of ultraviolet irradiation and had not responded to that stimulus were suspended from a raft in front of (5 m water depth). our Centre. Five days later this group was again stimulated. This time they were warmed to 12.3°C to 12.7°C and 6 units of ultraviolet radiation were used. None of them responded, but when warmed on the next day to 14.4°C to 16.2°C there was a 40% response.

In the third trial three-year old scallops collected from suspended cultivation at Yokohamacho were used. At 9.9°C the response to 6 units was 10% and at 11.0°C to 12.8°C the response to 4 units was 10%, to 5 units 40% and to 6 units 20%. The response to 4 units or 5 units at 14.1°C to 15.0°C was 20%. However in all cases there was no response to zero or three units.

2.2 Scallop ripeness and the conditions for inducing spawning

Materials and methods

The scallops used in the trials were three-year old scallops brought from suspended cultivation on 6 February 1975 in Moura (Hiranaicho). The shell lengths were 8.9 cm to 12.1 cm. After the scallops had been bought and transported to our Centre they were classified as male or female and housed in round

baskets (10 dan)* which were suspended at a depth of 5 metres in front of our Centre. 30 of each sex were used to measure ripeness and five of each in inducing spawning.

The method of inducing spawning was the same as in section 2 - 1, but in 2 - 2 the inducing stimulus was warmed filtered seawater at about 12 °C and about 15 °C irradiated with 6 units of ultraviolet radiation. The spawning induction was terminated five hours after the start. In the first trial, using filtered ultraviolet irradiated seawater (warmed to about 12 °C) the scallops were set aside in a current of filtered water as in Section 2.1, and the next day the same individuals were used (those which had spawned or discharged sperm being replaced by new ones) and spawning was induced by the same method (but with the ultraviolet irradiated water warmed to about 15 °C).

Results and discussion

The changes in the gonad indexes of the scallops used in the trials and the season spawning states are shown in Figure 5.

As Figure 5 shows, 3 individuals out of 10 responded by spawning on 6 and 7 February when seawater irradiated by ultraviolet and warmed to 12 °C was used, and 4 individuals out of 10 at 15 °C. One female individual had spawned 10.54 million ova in 2 hours 15 minutes from the start of induction. Three of the five males discharged "much" sperm. According to this it is considered that on 6 February the three-year old scallops in suspended cultivation in the Moura district were in a satisfactory condition

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* Dan I have not been able to determine the exact meaning of this term. The character used implies "levels" or "stages". See also Section 4.2. Translator.

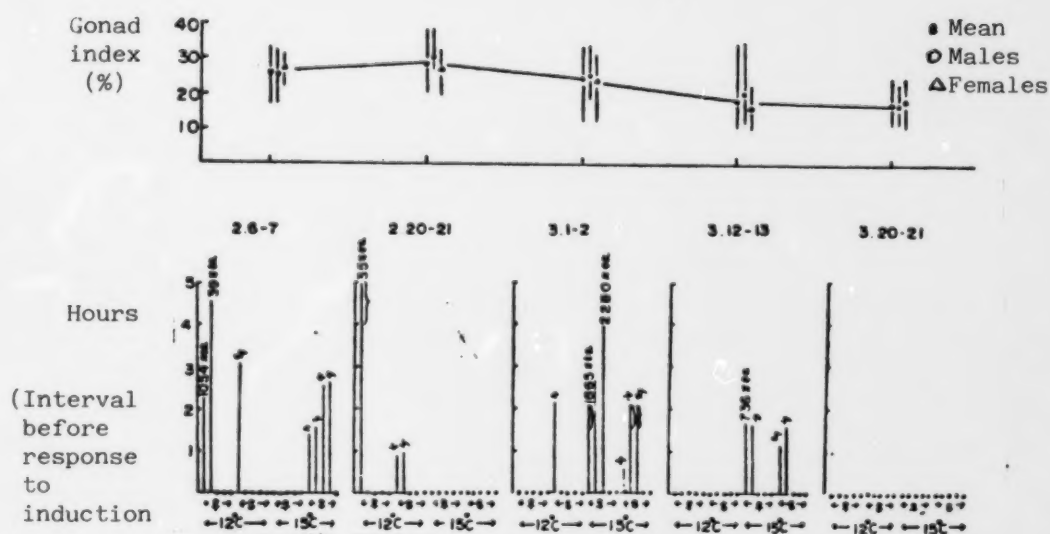


Figure 5. Condition of induction of scallop spawning.

(Three year old scallops from suspended cultivation at Moura).

⌈ Spawning was delayed.

for spawning and discharging sperm (gonad index 26.3 ± 4.1 (17.2 to 32.0)%). On 20 - 21 February the gonad index was 24.6 ± 5.5 (12.1 to 33.9)%, almost the same as on the former occasion (6 - 7 February) but few individuals responded to induction of spawning. At 12°C the quantity of ova spawned by one female about 5 hours after the start of induction was only 350,000, and only two males discharged a "little" sperm. On 1 - 2 March the number of individuals responding to induction increased. Two of the 4 males discharged "much" sperm. Two females responded, one producing 18.56 million ova and the other 22.8 million ova. The gonad indexes during induction on 12 - 13 March and 20 - 21 March were lower and few individuals responded to the induction, none at all responding on 20 - 21 March.

2.3 Ripeness and spawning induction in relation to the depth of suspension of the scallops²

Materials and methods

The scallops used in the experiments were bought at Urada, Hiranaicho, and had been in suspended cultivation since 1973 (mean shell length 7.3 cm, mean weight 43.3 grams, measured on 22 October). After purchase they were transported to Kawauchi (Shimokita county) and suspended at depths of 15 m and 30 m in order to make comparisons of gonad ripeness and growth of scallops in relation to suspension depth. The experimental scallops were measured eight times between 22 October 1974 and 29 May 1975 and at the same time spawning was induced in order to observe the dependence on depth of the state of ripeness. Spawning of those collected on 24 January was induced on 31 January and 4 February, in those collected on 28 February on 1 March and 2 March, and in those collected on 20 March on 20 March and 21 March.

The method of inducing spawning was the same as in Section 2.2, and the water temperatures used for induction are shown in Table 2.

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Table 2

Water temperature during spawning induction

Units, °C

Date	31 Jan	4 Feb	1 Mar	2 Mar	20 Mar	21 Mar
Temperature range	12.5-12.7	14.0-14.7	11.7-12.7	14.0-14.4	12.7-13.6	14.7-15.6

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Results and discussion

The seasonal variations in gonad ripeness, in growth, and in the state concerning the induction of spawning are shown in Figure 6.

As can be seen in Figure 6, comparison of scallops suspended at different depths throughout the experimental period of 221 days from 22 October to 29 May reveals no appreciable difference between the growth of scallops suspended at the 15 m level and the growth of those at the 30 m level. During the experimental period the mean daily increase of shell length when suspended at the 15 m level was 95 microns per day, and when suspended at the 30 m level it was 95 microns per day. The increases in weight were similar to the increases in shell length, the mean daily increases in weight being 229 milligrams per day and 219 milligrams per day, so that no appreciable differences between the increases in weight at the two levels was found.

There was also no difference between the two depths of suspension in the changes of the sc allopat gonad indexes. As shown in Figure 6, the gonad indexes of scallops suspended at both depths showed maximum values from late February to early March, the gonad index varying at the 15 m level

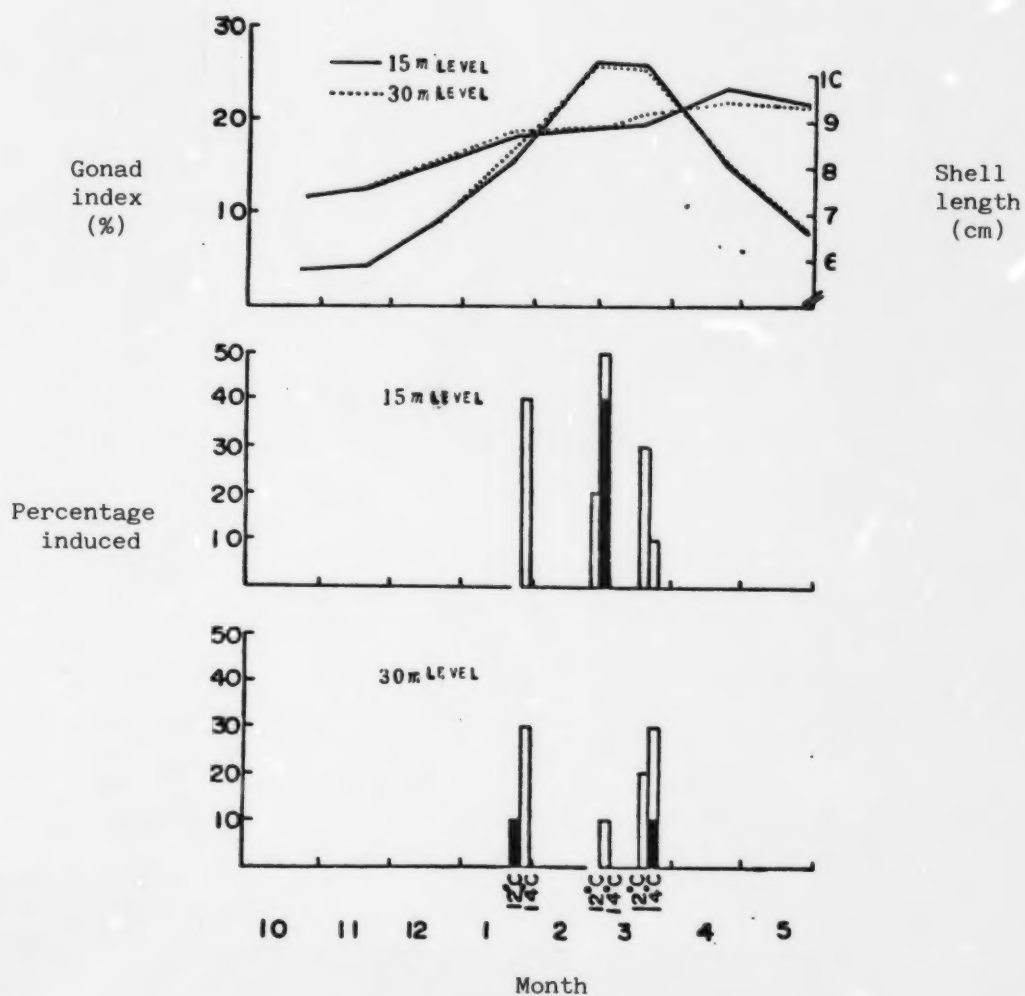


Figure 6. Percentage of scallops induced to spawn.

(according to season and suspension depth)

■ Females □ Males

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from late February to early March, the gonad index varying at the 15 m level from 28.7% to 26.2% and at the 30 m level from 26.1% to 25.6%.

The condition of the scallops in relation to the induction of spawning is shown in Figure 6 by the proportion of spawning induced. The seasonal changes in the scallop gonad ripeness shown in Figure 6 do not reveal any dependence or time displacement depending on depth of suspension. Nevertheless the number of scallops from the 15 m level which responded to spawning induction was 1.5 times the number from the 30 m level which responded. Of the eleven male scallops suspended at the 15 m level, three (27%) responded by discharging "much" sperm. Of the four females which responded to spawning induction, three released their ova in from 1 hr 30 min to 2 hr 05 min after the start of induction, the individual releases being 8.59 million, 3.57 million and 4.35 million ova. The fourth released 2.28 million ova 4 hr 30 min after the start of induction. Two of the eight males (25%) suspended at the 30 m level responded to spawning induction by discharging "much" sperm. Two of the females responded to spawning induction, one producing 2.7 million ova 2 hr 10 min after the start of induction, and the other 4.8 million ova 2 hrs 05 min after the start.

No notable differences in growth were found on comparing the two levels of suspension, and the states of ripeness were the same. However the proportions which were induced spawn lead to the conclusion that those suspended at the 15 m level were more easily able to respond to spawning induction than those suspended at the 30 m level.

3. The rearing and transfer to the sea of
free-swimming scallop larvae

The method used for rearing free-swimming larvae was exactly the same as that which has already been reported in this Journal and is omitted here. The mother scallops were stimulated to spawn by being placed in a current of warmed, ultraviolet irradiated water.

Settled scallops were suspended on 28 April 1975 in scallop rearing facilities located in Okunai, Aomori city. Scallop spat with shell lengths about 1.0 to 2.5 millimetres which had settled on spat collectors of hemp palm bark at our Centre were transported while still settled on the hemp palm bark collectors which were placed in andon^{*} nets of 1 bun (3.03 mm) mesh. On the boat the andon nets were covered in soaked straw matting. Transport from this Centre to the location took about 45 minutes, and the scallops were suspended immediately on arrival. Transport on 1 May was from this Centre to Tsuchiya (Hiranaicho) as on former occasions. A difference from former occasions was in the transport of the spat collectors placed in fish holding tanks which caused scallops to fall off inside the tanks by the time of arrival at the site.

The growth of scallops suspended at Okunai (Aomori city) is discussed in Section 4 "The growth of settled scallop spat".

* Andon net. I have not found an exact description of this. Normally, an "andon" is a roughly cubic shade for a traditional lamp and this may describe the shape of the net. Translator.

4. The growth of settled scallop spat

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4.1 The growth of settled scallop spat (from natural sources)

Materials and methods

The objective of these experiments was to obtain data on the growth and survival rate of early stage settled scallop spat and also about the transfer to the sea of cultured early stage settled spat. The early stage settled spat were obtained from the natural seedlings (1 July). As shown in Table 3, these early stage settled spat were divided into three groups of 50 individuals each according to shell lengths, 1 to 2 mm, 2 to 3 mm and 3 to 4 mm, and placed in dishes covered with netting. These were placed in pearl nets and suspended at a depth of 5 m in front of our Centre. The increase in shell length and the survival rate of each of the groups was measured on 6 occasions from the start of the experiment on 1 July to its termination on 20 September.

Results and discussion

The results of the experiment are shown in Table 3 and Figure 7. The increases in the shell lengths of the groups between 1 July and 20 September were 7.8 mm, 8.5 mm and 9.1 mm. Between 1 July and 24 July the mean daily rates of growth of the separate groups were as follows:-

The 1 mm to 2 mm size group	104 microns per day
2 mm to 3 mm " "	130 " " "
3 mm to 4 mm " "	165 " " "

However between 16 August and 20 September the rates of growth were in opposite order to those just after settling, being 71 microns per day, 68 microns per day and 40 microns per day. This can be supposed to

Date	Shell length mm	Range	Shell height mm	Range	Survival rate %
01 July 1974	1.8 ± 0.2	(2.0 - 1.4)	1.8 ± 0.2	(2.1 - 1.5)	100
12 July 1974	2.7 ± 0.3	(3.2 - 1.7)	2.6 ± 0.3	(3.2 - 1.8)	94
24 July 1974	4.2 ± 0.5	(5.2 - 3.2)	4.2 ± 0.5	(5.2 - 3.3)	86
05 August 1974	5.7 ± 0.7	(6.9 - 4.4)	5.8 ± 0.7	(7.0 - 4.5)	82
16 August 1974	7.1 ± 0.8	(8.8 - 6.2)	7.5 ± 0.8	(7.2 - 6.1)	80
20 September 1974	9.6 ± 1.0	(11.8 - 8.1)	10.3 ± 1.0	(12.4 - 8.4)	78

1 mm to
2 mm
size

01 July 1974	2.5 ± 0.3	(3.0 - 2.0)	2.5 ± 0.3	(2.9 - 1.9)	100
14 July 1974	3.8 ± 0.4	(4.6 - 2.9)	3.8 ± 0.4	(4.5 - 2.8)	98
24 July 1974	5.5 ± 0.6	(6.6 - 4.2)	5.7 ± 0.6	(6.8 - 4.3)	98
05 August 1974	6.8 ± 0.8	(8.2 - 4.7)	7.1 ± 0.8	(8.6 - 4.7)	94
16 August 1974	8.6 ± 0.9	(10.2 - 6.8)	9.1 ± 1.0	(11.8 - 7.2)	94
20 September 1974	11.0 ± 1.3	(13.5 - 8.3)	11.8 ± 1.4	(14.3 - 9.0)	76

2 mm to
3 mm
size

01 July 1974	3.4 ± 0.2	(3.9 - 0.3)	3.3 ± 0.2	(3.8 - 3.0)	100
14 July 1974	5.0 ± 0.3	(5.8 - 4.3)	5.1 ± 0.3	(5.9 - 4.4)	100
24 July 1974	7.2 ± 0.4	(8.0 - 6.3)	7.4 ± 0.4	(8.4 - 6.4)	100
05 August 1974	8.7 ± 0.5	(9.8 - 7.7)	9.0 ± 0.5	(10.1 - 8.0)	98
16 August 1974	10.1 ± 0.7	(11.8 - 9.0)	10.7 ± 0.7	(12.2 - 9.5)	98
20 September 1974	11.5 ± 0.9	(13.4 - 7.6)	12.2 ± 1.0	(14.1 - 10.5)	96

3 mm to
4 mm
size

	Mean daily increase in shell length (microns per day)	Mean daily increase in shell height (microns per day)
01 July 1974	-	-
14 July 1974	115	118
24 July 1974	142	161
05 August 1974	142	128
16 August 1974	152	164
20 September 1974	61	67

Table 3. Growth and survival of settled scallop spat according to size.

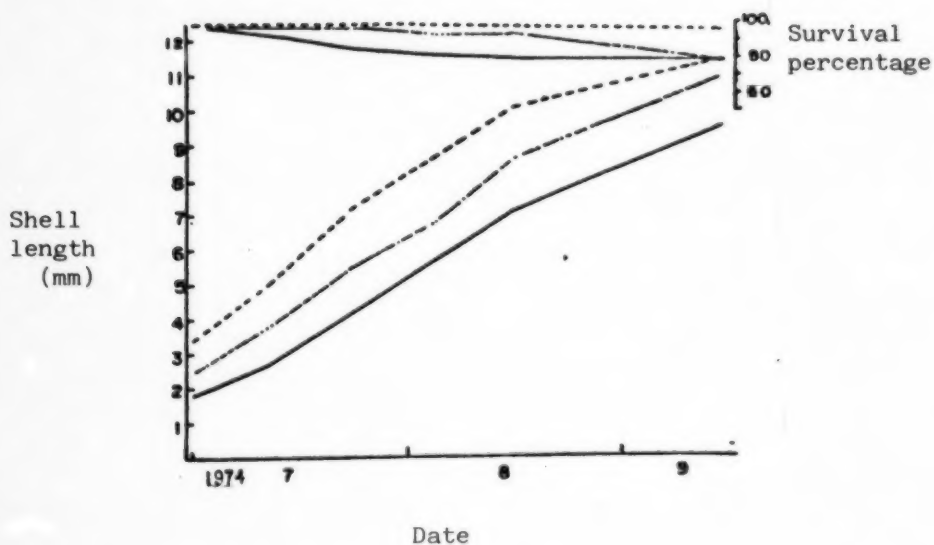


Figure 7. Growth of first season settled scallop spat.

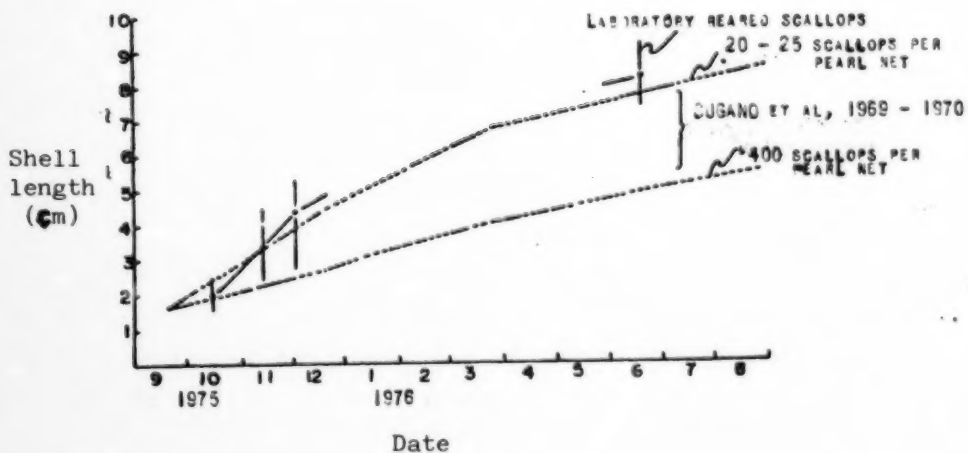


Figure 8. Growth of scallop spat (from laboratory rearing).

be due to the increase in density as the spat grew in comparison with the size of the container. The evident effect which ^{at the time of} the dispersal of the ^{collected} spat

the roominess of the housing provided has on the subsequent shell growth ^{in the case of settled spat} has already been investigated³. However it is difficult to judge correctly the "roominess" of the housing provided for scallop spat at the time of dispersal. In the present experiments it is considered evident that the larger settled spat grew more rapidly than the smaller ones.

The survival rate at the end of the experiment on 20 September was 78% for the 1 mm to 2 mm size and also for the 2 mm to 3 mm size. For the 3 mm to 4 mm size group it was 96%. It is not known whether the reason for this decrease is the period used or is a natural decrease affecting the size groups. In natural conditions there will be predation by starfish before and after the season of collection, and there was no starfish predation in these experiments.

(1) The settled spat in all groups were already settled on a collector at the start of the experiment on 1 July but artificially peeled off and arranged into the size groups mentioned.

(2) After being peeled off the settled spat were measured (using an all-purpose projector), housed in a container and immediately suspended in the sea.

Thus there was no change of water temperature as there would be when artificially reared settled spat are moved from the laboratory where the water temperature is 15°C to 16°C to the sea where the water temperature (at Moura, Hiranaicho in April to early May 1974) was from 5°C to 13.3°C. As has already been said, it is difficult to compare the results of these

experiments with the growth and loss of settled spat obtained from artificial cultivation. However it is considered that when settled scallop spat is taken from artificial cultivation and acclimatized to the temperature of the natural sea water the growth of the settled spat in the 1 mm to 2 mm size will be close to the value obtained here.

4.2 The growth of settled scallop spat (from artificial sources)

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Material and methods

The scallops used in these experiments were those which, as mentioned in Section 3 "The rearing and transfer to the sea of free-swimming scallop larvae" had been obtained already settled from laboratory rearing and transferred to the sea in scallop rearing facilities at Okunai, Aomori city on 28 April. When dispersal first became possible they were taken from the collectors and housed in pearl nets of 1 bun (3.03 mm) mesh. At the second dispersal on 15 October they were housed in pearl nets of 1.5 bun (4.54 mm) mesh at the rate of 25 per net. At the third dispersal on 3 February they were housed in pearl nets of 3 bun (9.1 mm) mesh at the rate of 15 per net. Later they were transferred on 3 June 1976 without dispersal into round baskets (10 dan^{*}), mesh size 7 bun (21.2 mm) at 15 per dan. The size of the spat was measured at each dispersal and compared with the growth of spat which had been produced in the laboratory in 1975 and measured on 2 December 1975 and which between 3 and 13 December had then been placed for the middle rearing period in commercial rearing facilities at Funaoka (Tairadate village), Ushirogata (Aomori city) Okunai (Aomori city) and Yokohamacho.

* Dan. See Section 2.2. Translator.

Results and discussion

After removal from the collectors, the spat were dispersed three times in a year, and on a fourth and final dispersal operation on 3 June they were transferred into round baskets with 7 bun (21.2 mm) mesh. The growth of the spat during this period is shown in Figure 8. Sugano et al.³ had also measured the growth of the spat in pearl nets with 20 to 400 per net, and these are shown for comparison in Figure 8. This comparison of the growth of the spat transferred to the sea off Okunai (Aomori city) with the growth of the scallops housed at various densities in Sugano's experiments shows, as can be seen in Figure 8, that the growth obtained exceeded the best growth obtained by Sugano at 20 to 25 per pearl net. According to the "Study of the actual condition of the scallops (24 to 28 May)" made in 1976 by Aomori prefecture, the mean shell length of scallops born in 1975 at 13 branches of the Mutsu Bay cooperative was 5.3 cm (2.6 to 8.5 cm) which was exceeded by about 2.5 cm by the mean shell length of the laboratory reared scallops (the total weight was 17 scallops per kilogram). Comparison in early December of the growth of scallops of the same year from different regions with those from laboratory rearing shows, as in Table 4 and Figure 9, that the shell length was greater by 1.3 to 1.8 times and the overall weight was greater by 2.2 to 5.0 times.

When spat from laboratory rearing was compared with spat from natural sources, the growth was never found to be inferior. The shell length of the laboratory scallops at the time (28 April) of transferral to the sea is already 1.0 to 2.5 mm. Those from natural sources are at that time still at the settling stage, whereas the laboratory scallops settled earlier. In an average year, spat is collected from the natural

Date	Shell Range length (cm)	Shell Range height (cm)	Shell Range width (cm)	Over- Range all weight (g)	Remarks
15 Oct 1975	$2.0 \pm 0.3 (2.5-1.6)$				From laboratory rearing
13 Nov 1975	$3.4 \pm 0.5 (4.5-2.4)$	$3.4 \pm 0.5 (4.4-2.4)$	$0.8 \pm 0.1 (1.0-0.5)$	50	
02 Dec 1975	$4.4 \pm 0.6 (5.3-2.7)$	$4.3 \pm 0.5 (5.1-2.8)$	$1.0 \pm 0.2 (1.3-0.6)$	$9.9 \pm 3.2 (16-3)$	
19 Jun 1975	$8.2 \pm 0.5 (9.2-7.4)$	$8.0 \pm 0.5 (8.9-7.2)$	$2.0 \pm 0.1 (2.2-1.7)$	$58.9 \pm 9.9 (83-42)$	
03 Dec 1975	$3.0 \pm 0.4 (3.7-2.4)$	$3.0 \pm 0.4 (3.7-2.3)$	$0.7 \pm 0.1 (0.8-0.5)$	3.3	Funaoka (Ta:radate)
05 Dec 1975	$3.4 \pm 0.2 (3.8-3.2)$	$3.5 \pm 0.2 (3.8-3.3)$	$0.7 \pm 0.1 (1.0-0.6)$	3.7	Ushirogata (Aomori)
02 Dec 1975	$2.5 \pm 0.5 (3.9-1.9)$	$2.6 \pm 0.5 (3.8-2.1)$	$0.5 \pm 0.1 (0.8-0.4)$	20	Okunai (Aomori)
13 Dec 1975	$3.2 \pm 0.3 (3.9-2.7)$	$3.3 \pm 0.3 (3.8-2.8)$	$0.7 \pm 0.1 (0.8-0.5)$	$4.5 \pm 0.1 (7-3)$	Yokohamacho

Table 4. Growth of laboratory reared scallop spat.

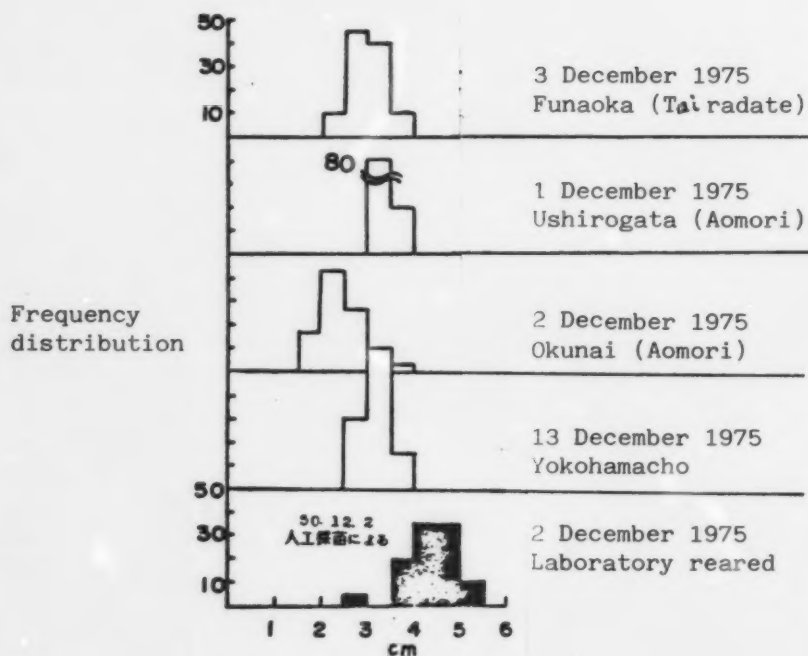


Figure 9. Shell length distribution of scallop spats.

rearing ground in late July to late August, but since in recent years a considerable number of spat have already settled, it is to be supposed that in natural circumstances, the settling period is ^{delayed} so that, there is no difference in size between the ^{because of the many settlings} which settle for the first time and the ^{and} which settle for the "Xth" time ^{and} so that the small ones are averaged out. Thus in natural conditions there is no relation between the settling season and the stage which they have reached when collected. The settled spat which are retained on a "screen" with a certain size mesh are known as the "first offspring". In the present experiments when individuals born from the same male and female parents have been transferred to the sea, once again only those which are retained by a pearl net with a 1 bun (3.03 mm) mesh will be collected. There is thus a group of good growth among those of the same parentage (perhaps this is the true meaning of "first offspring"). In natural conditions, all those of shell length more than 1 cm in late July to late August are completely removed, and consequently when as in recent years spat settled in large numbers, those which did so for the first ^{those which} time ^{and} settled for the "Xth" time ^{and} show almost no changes in size, ^{and} most of them will have had growth in the interval from the first to the "Xth" settling but will be called "first offspring". Thus when the settled spat have arrived at the percentage in the frequency distribution at which they will settle in a pearl net of 1 bun (3.03 mm) or 1.5 bun (4.54 mm) mesh or will be sieved out by a 1 bun (3.03 mm) or a 1.5 bun (4.54 mm) sieve, it is thought that it will be satisfactory to accommodate them in a pearl net of the same mesh with few of them in each net. Even so, a further point to be discussed will be

the prevention of damage due to the introduction of hostile organisms such as starfish and Saxicava. There may be differences which depend on the locality but it is also thought that fouling of the net will hinder the growth of the spat.

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References

1. TANAKA Toshisuke, ta

Hotategai no shubyo seisan. Sanran yuhatsu ni tsuite

Hon shi dai 5 go 28 - 31

Tanaka, T., et al

The production of scallop seedlings. On the induction of spawning.

This Journal, No. 5 28 - 31.

2. Aomori ken (1976)

Showa 50 nendo kokudo sogo kaihatsu jigyo choseihi shosa.

Mutsuwan gyogyo kaihatsu kihon keikaku chosa hokokusho 73 - 81

Aomori prefecture (1976)

1975 survey, National funding for joint economic development.

Report of the basic plan for fishery development in

Mutsu Bay, 73 - 81.

3. SUGANO Hiroki ta (1973)

Hotategai no zoyoshoku ni kansuru kenkyu II

Hotategai no chukan ikusei shiken

Honshi dai 2 go 18 - 20

3. Sugano, H. et al (1973)

Studies of scallop culture II.

Experiments on the intermediate growth of scallops.

This journal, No. 2, 18 - 20.

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